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Session:

Numerical simulation and hybrid modelling of a 3-D laminar wing in transonic regime

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Introduction

The present paper details the simulations carried out for the 3D-V2C wing configuration designed by Dassault Aviation in the context of the TFAST - Transition location effect on shock boundary layer interaction - European programme. The transition location is imposed by numerical tripping of the eddy-viscosity. Based on previous detailed studies of the present research team, [2], [3], the optimum transition location is of order 30%, in order to avoid that buffet includes this position, because very strong unsteadiness wold be created, as for example in the case of 55% of fixed transition. The computations have been carried out comparing URANS and DDES approaches. The k-ω-SST and k-ω-OES [1] models have been used, as well as the DDES-OES. The results compare the behaviour in respect of transonic buffet appearance along the span. because of the chord's length variation, there are sections where the local Reynolds number is subcritical or supercritical regarding the buffet instability. These aspects are studied in detail in the present work.

Results

The 3D - V2C configuration by Dassault Aviation has been computed by using the above mentioned turbulence modelling in the code NSMB - Navier-Stokes MultiBlock. The physical parameters are: Re=4.47e6 in mid-span, Mach=0.745, angle of attack, a=5deg. The grid is of 9 Million points.

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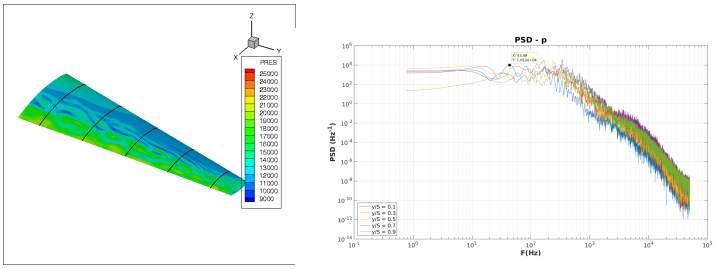

Figure 1. Iso-pressure contours along the span for the case of fixed transition at 30% and pressure spectra along the span

The pressure iso-contours along the span illustrates a strong unsteady behavior according large-scale wavelength undulations. These are also related to the development of buffet. As the chord's length varies in the present configuration, the local Reynolds number varies along the span and therefore, the appearance of buffet mode and its predominant frequency. There may exist sections where this mode is not well pronounced, whereas other sections along the span, where this mode is clearly emerging from the energy spectra, as shown in the following. The buffet frequency is also shown in the spectra of Figure 1, where it varies from 70 to 200 Hz approximately in different spanwise positions. In this paper the influence of the turbulence modeling approaches in respect of buffet prediction spanwisely will be discussed in detail, as well as the interaction with the shear layers and the near wake.

References

[1] D. Szubert, F. Grossi, A. Jimenez-Garcia, Y. Hoarau, J. Hunt, M. Braza, "Shock-vortex shear-layer interaction in the transonic flow around a supercritical airfoil at high Reynolds number in buffet conditions", J. Fluids & Structures, 55, pp. 276–302, (2015).

[2] D. Szubert, I. Asproulias, F. Grossi, R. Duvigneau, Y. Hoarau, M. Braza "Numerical study of the turbulent transonic interaction and transition location effect involving optimisation around a supercritical airfoil", European Journal of Mechanics-B/Fluids, 2015, 55, N° 2, pp. 380-393.

[3] F. Grossi, M. Braza, Y. Hoarau "Prediction of Transonic Buffet by Delayed Detached-Eddy Simulation", AIAA J., 52, N°10, 2014, pp. 2300-2312